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IAPER AND ANNEX

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT Article 36 and Rule 70)

Applicant's or agent's file reference 99693-6507-LA		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/IB2003/005023	International filing date (day/month/year) 05.11.2003	Priority date (day/month/year) 05.11.2003	
International Patent Classification (IPC) or both national classification and IPC H01M2/16			
Applicant HIBAR SYSTEMS LIMITED et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 6 sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> I <input checked="" type="checkbox"/> Basis of the opinion II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input type="checkbox"/> Certain defects in the international application VIII <input type="checkbox"/> Certain observations on the international application 			
Date of submission of the demand 27.01.2005		Date of completion of this report 07.02.2006	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized Officer Boussard, N Telephone No. +49 89 2399-7196 	

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/IB2003/005023

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1, 5-10 as originally filed
 2-4 received on 27.01.2005 with letter of 24.01.2005

Claims, Numbers

1-16 received on 27.01.2005 with letter of 24.01.2005

Drawings, Sheets

1/6-6/6 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☒ the claims, Nos.: 17
☐ the drawings, sheets:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/IB2003/005023**

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	7-16
	No: Claims	1
Inventive step (IS)	Yes: Claims	7-16
	No: Claims	1-6
Industrial applicability (IA)	Yes: Claims	1-16
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1. Reference is made to the following documents:

D1: PATENT ABSTRACTS OF JAPAN vol. 007, no. 178 (E-191), 6 August 1983 (1983-08-06) & JP 58 082465 A (MATSUSHITA DENKI SANGYO KK), 18 May 1983 (1983-05-18)
D2: PATENT ABSTRACTS OF JAPAN vol. 1996, no. 01, 31 January 1996 (1996-01-31) & JP 07 245091 A (MATSUSHITA ELECTRIC IND CO LTD), 19 September 1995 (1995-09-19)
D3: US-B1-6 270 833 (YAMASHITA KATSUHIRO ET AL) 7 August 2001 (2001-08-07)

2. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is not new in the sense of Article 33(2) PCT.

Claim 1 discloses a cylindrical separator for cylindrical cells, comprising a cylindrical body constituted by a multi-layered non-woven sheet material wound around a mandrel and a bottom part formed from the extension of said cylindrical body by wetting, folding and fusing. Such a separator is well-known from the prior art (see D1, D2 or D3 (col 3, lines 4-6 and 48-67; col 4, lines 1-20)). The claimed separator is further defined by the steps of its manufacture, which however cannot distinguish the claimed separator over the prior art. Consequently any document which discloses a separator as defined above - even if obtained by a different process - takes away the novelty of the claimed subject-matter.

Claim 1 therefore lacks novelty with regard to the cylindrical separators disclosed in documents D1, D2 and D3.

3. Dependent claims 2-6 do not contain any features which, in combination with the features of claim 1 to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step.
4. Claims 7-16 are directed towards a method for making a cylindrical separator closed

at the bottom by winding a sheet separator material around a rotating mandrel and then wetting, folding, drying and fusing the bottom part formed from the extension of said wound sheet.

The method claimed in the present application differs from the methods known from D1 or D2 in that in the folding step, the rotating mandrel and separator are guided above a stationary rail provided with a forming groove with varying profile, the extended portion is then inserted into said groove having a profile corresponding to that of the head portion of the mandrel and the wetted extended portion is gradually folded from the edge towards the central zone to close the bottom part.

The technical effect achieved thereby is a simple and easy manufacturing process for making a wrinkle-free and perfect separator bottom closure.

Such a guided and supported folding is not disclosed or suggested in the cited documents D1 or D2, wherein the extended portion is pressed in a downward movement against a stationary die leading to wrinkles and a poor bottom closure. Moreover D2 involves an additional cut step and the need of a separate cup to provide the required sealing. Claims 7-16 therefore are novel and inventive.

Consequently claims 7-16 meet the requirements of Article 33(1) PCT.

US patent 6,541,152 shows a different design also utilizing an insulating cup at the bottom and it has the same problem of decreasing useful cell volume and requires the handling of two separate material parts.

- 5 US patent 6,270,833 does not use any cup but the separator is made longer than the required useful length in the cell, the windings of the cylindrical separator body are bound together with a binder, and the extended portion is first pushed inwardly by a tool moving normal to the cylinder axis then folded back to close the initially open end. The folded and closed separator forms a self containing unit that should then be inserted into the cell. The
- 10 smooth insertion requires a small clearance between the inner diameter of the cathode rings and the separator, which could increase cell resistance. The closing operation of the bottom part is complicated and requires movements in different directions, and problems can arise by the inevitable appearance of wrinkles.
- 15 US patent 6,035,518 describes a different method of making the separator, in which the separator material is wound around a mandrel and the winding is kept on the mandrel by a vacuum, and the separator does not constitute a self-containing unit, it should be guided until insertion into the semi-finished cell, wherein the winding tries to open up and fill the whole available space. While the idea of guiding the separator until insertion into the cell
- 20 is preferable, the key problem, i.e. the closing of the bottom is solved here by the application of a hot melt sealant to fill the cell bottom including the bottom region of the separator. The presence of a sealant at the active lower region of the separator also decreases the available useful cell volume.

- Japanese patent publication Sho58-82465 published on May 18, 1983 describes a method
- 25 for making the separator, in which a multi-layered separator sheet material is wound around a core so that the bottom part of the wounded separator sheets extends out of the core along a predetermined length, then during rotation of the core and of the sheet material thereon the extended portion is contacted with a water wet felt to soak the sheet material with water and make it softer, and this soft extended part is inserted in a die to
- 30 close the bottom part and in a further step the closed bottom part is heat-dried in a further tool. This method could not provide a wrinkle-free and perfect bottom closure, because the

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rotating wet extended separator bottom part was moved axially in the die and first the end portion of the sheet got into contact with the die, and during the further downward movement of the rotating cylinder, wrinkles were formed and the soft wet material could not take a precise form. The wetting with a wet felt could not result in an evenly distributed and controlled amount of water in the whole area of this extended portion.

An improvement of the aforementioned method was published in Japanese patent publication Hei6-35662, wherein the disadvantages of the previously mentioned method were seen in the increased thickness of the curled bottom part. In the improvement cut slits were made in the extending bottom end of the multi-layered separator sheet material before the sheet material was wound around the core to remove a portion of the excess material from this bottom part, then practically the same steps were carried out as in the previous method, i.e. wetting and curling the bottom part by pushing the same in a die in vertical direction followed by a heat drying. In this method owing to the removal of a portion of the separator material the thickness was reduced, however, the separator bottom part was not securely closed and there was a need of inserting a separate closing cup in the interior of the bottom part of the separator (element 64 in Fig. 5 of the publication). The presence of this cup decreases the active volume of the cell interior and its placement requires a further step in the manufacturing process.

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A further problem characteristic to separators used for secondary cells lie in that often a laminated structure should be used, since in case of secondary cells a thin semi permeable membrane layer, such as a cellophane layer should be provided. Two or more layered laminates are expensive and adhesives used to affix the layers contribute to higher internal resistance.

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There is a further issue concerning separators that concern the need of synchronization with the general cell manufacturing process. State of the art processes produce at high speeds of 600 to 1200 parts per minute, and this high speed favors or requires easy to use technologies that can fit into the manufacturing line, rather than preparation of off-line, pre-fabricated separators, which can cause problems from additional handling.

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Object of the Invention

The primary object of the invention is to enable maximum utilization of available cell
5 volume. A further object is the combination of the unfolding nature of the guided separator
as taught in the above referred US patent 6,035,518 with the reliable establishment of a
closed bottom that does not require the application of a sealant in the useful cell area, or
overcoming the disadvantages of the methods described in the cited Japanese publications.
Yet another object of the invention is to provide on-line adjustments of the sheet material
10 length without the changes of any hardware components. A different object is to provide a
separator that does not require the use of a laminate sheet if a multi-layered structure is
required e.g. for secondary cells. A still further object is to provide a method that is
simple, easy to make and which can provide synchronization with the cell manufacturing
process.

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Summary of the invention

These objects have been met by providing a separator and a method for making the same
as defined and described in the attached claims.

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Description of the drawings

The invention will now be described in connection with preferable embodiments thereof,
wherein reference will be made to the accompanying drawings. In the drawing:

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Fig.1 shows the schematic top view of the sheet feeding station;

Fig.1a is the simplified elevation view of a part of Fig. 1;

Fig.2 is a similar view as Fig. 1 adapted for feeding two sheets;

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Claims:

1. A cylindrical separator for cylindrical cells, comprising a cylindrical body
5 constituted by a layered structure of a plurality of turns of at least a non-woven sheet
material wound around a mandrel, and a bottom part closing a first end of said cylindrical
body, wherein said bottom part being formed from the extension of said cylindrical body
when being rotated in a wetted state, and fused by a heated die, characterized in that said
wetted state is provided by the spraying of a predetermined amount of liquid, and said
10 folding is provided by a gradual deformation in said rotating state proceeding from the
edge towards the central zone by moving said rotating body along a stationary forming
groove profiled gradually to the required shape of said bottom part, wherein a support is
provided at the interior of said body having a support surface defining said required shape
and said supporting surface and said profiled groove defining together a narrow space for
15 said bottom part.

2. The cylindrical separator as claimed in claim 1, wherein said cylindrical body being
made from a plurality of sheets placed onto one another and wound together.

3. The cylindrical separator as claimed in claim 2, wherein said sheets comprise at least
one layer of a semi-permeable membrane and cellophane in addition to said non-woven
20 sheet material.

4. The cylindrical separator as claimed in claim 1, wherein said turns being not affixed
to each other.

5. The cylindrical separator as claimed in claim 1, comprising a thermoplastic sealant
arranged at the central zone on the outside of said bottom part.

25 6. The cylindrical separator as claimed in claim 1, wherein said bottom part being
pressed during heat drying and fusing before insertion into the cell.

7. A method for making the cylindrical separator closed at the bottom, for batteries
with a hollow cylindrical interior, comprising the steps of:

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- providing a sheet separator material of predetermined length and width, wherein the width being at least as long as the length of the cylindrical portion of the separator plus an extended portion being at least as long as the half diameter of the separator;
- 5 - winding said sheet material around a mandrel by rotating said mandrel, wherein said mandrel extending till the end of said cylindrical portion of the separator and having a head portion at the lower end shaped to define the required profile of said closed bottom part;
- supporting the outside of the winding by means of a stationary winding nest;
- 10 - applying a predetermined amount of water to said extended portion during any of the foregoing steps to soften said sheet material at the extended portion;
- guiding said rotating mandrel and separator when placed in said winding nest above a stationary rail provided with a forming groove with varying profile so that said extending portion is engaged in said groove that has a profile
- 15 conforming to that of said head portion to gradually fold said wetted extended portion from the edge towards the central zone and to close thereby the bottom part of said separator;
- causing said mandrel and said separator to stop rotation;
- drying and fusing said wet closed bottom part by the application of heat and a
- 20 predetermined pressure; and
- introducing said separator into the cylindrical cavity of a semi-finished cell from said winding nest by pushing said closed bottom portion of the separator by means of axial movement of said mandrel; and
- withdrawing said mandrel from the interior of said separator.
- 25 8. The method as claimed in claim 7, wherein at least two sheet materials placed on one another being wound during said winding step.

9. The method as claimed in claim 7, wherein said water application step being carried out prior to said winding step.

10. The method as claimed in claim 8, wherein the second sheet being a semi-permeable membrane.

5 11. The method as claimed in claim 7, further comprising the step of slightly pressing said rotating separator on said mandrel from the outside by a belt moved with the required peripheral speed of the rotating separator through the whole period of rotation.

12. The method as claimed in claim 7, wherein said drying and fusing step being carried out by a heated die shaped to the required profile of said separator bottom portion.

10 13. The method as claimed in claim 7, further comprising the step of applying a thermoplastic sealant of predetermined volume on the central zone of said bottom portion following said drying and fusing step and prior to said introduction step.

14. The method as claimed in claim 7, wherein said mandrel comprising a sleeve and a pin therein, said head portion being provided on said pin, and said sleeve defining a recess
15 for receiving said head portion.

15. The method as claimed in claim 14, wherein during said withdrawing step said sleeve being withdrawn first followed by withdrawal of said pin.

16. The method as claimed in claim 7, wherein all of said steps being synchronized with a cell manufacturing line.